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COMPRESSION OF COTTON AT COTTON GINS

By

Charles A. Bennett, Senior Mechanical Engineer
U. S. Department of Agriculture
Bureau of Agricultural Chemistry and Engineering

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Until the ginned cotton fiber has been packaged in suitable form to enter trade channels, the ginning processes cannot be considered as completed. On this final and very important step in ginning, the Cotton Ginning Laboratory of the United States Department of Agriculture at Stoneville, Mississippi, is conducting research under a Bankhead-Jones special research project, and is obtaining much needed engineering and technological data. The Bureau of Agricultural Chemistry and Engineering and the Agricultural Marketing Service cooperate by handling their respective phases of the investigation.

Cotton bales in the United States are now handled in three densities, measured in pounds of cotton per cubic foot of bale volume after the bale has left the press. Flat or square bales coming from plantation and public gins have usually been packed to an average density of 13 pounds per cubic foot; standard-density bales for domestic shipment have been the usual gin bales compressed at concentration points to an average density of 24 pounds per cubic foot; high-density bales for export have been those which were compressed or recompressed to an average density of about 33 pounds per cubic foot.

Trade in flat or square bales of cotton from gins in the United States is based upon 500 pounds gross weight with an allowance of 22 pounds for tare; the tare includes about 12 pounds for 7½ square yards of jute bagging and approximately 10 pounds for six metal ties and buckles.

The net weight of cotton fiber in a gin bale is supposed to be 478 pounds. Actually, there is no rigid standardization in cotton bale weights at the gins, because the seed cotton loads may gin out to produce bales varying from 300 pounds to 800 pounds, and averaging about 500 pounds.

Development of Cotton-Gin Presses

Early cotton-gin presses were constructed of wood with post-oak screws and heavy sweeps operated by a team of horses or mules to produce a downward thrust in the cotton box. In isolated instances, these were followed by iron-screw presses which were invented shortly before the Civil War. Later, factories engaged in quantity production of presses brought out screw presses to be driven with the motive power of the gin; these usually had a single cotton box, so positioned that only the upper half protruded above the working floor. Modern presses, except in roller ginneries, are double-box presses, so designed that one box can be filled while the bale in the other is being pressed and tied. There are, however, many single-box presses still in use in the southeastern states where individual condensers are attached to the gin stands and collecting lint flues are not employed.

Packing or tramping the cotton into the press box is a hand operation on most single-box presses, but the double-box units have employed power packers for many years. There are steam, hydraulic and mechanical types of power packers, the types being in turn divided into sub-types according to the method of control. Hand control on all of the early types of power packers was gradually superseded by mechanical control.

The rams or plungers for the final pressing stages have been generally confined to rams of the screw and hydraulic-plunger types, but some toggle-lever presses have been tried out.

In 1935, according to the Bureau of Census reports, there were 14,414 cotton gins, of which 12,779 were active. In these establishments there were 1,342 single-box presses, over 13,000 double-box presses, and 255 round-bale presses which employ neither screw nor hydraulic rams in their production of 250-pound round bales. In 1935 about 66 percent of the presses had hydraulic rams and the remainder were, with few exceptions, of the screw type.

It is estimated that in 1940 there were approximately 13,000 gins in the United States of which approximately 11,643 were active. Although the 1940 census reports are not yet available, it is estimated that the decrease in gins has been heaviest in the older types and that there are now about 75 percent of hydraulic presses and only about 25 percent of screw presses. It is doubtful whether there are now more than a thousand single-box press gins remaining in the country.

Present Practices with Gin Bales.

The cross-section (horizontal) dimensions of cotton-press boxes in this country are almost universally 27 by 54 inches.

The bales, when released from the press, expand to the average approximate dimensions of 28.5 x 56.0 x 44.4 inches.[1] Freight-car loadings vary in number of bales, but will average 30 to 32 bales per 40'-6" x 8'-6" x 8'-6" freight car, for shipment to the domestic or railroad compress centers.

The "tied-out" dimensions of bales of various types depend not only on the manner in which the ties are attached, but to some extent also on the number of ties used. Six ties are universally used on gin bales. Ties generally weigh 45 pounds per bundle of 30, with buckles attached. Stock ties are 138 inches long by 15/16 inches wide, and have a cross-sectional area of .038 square inch and a tensile strength of approximately 2,700 pounds per tie. Some ties are coated with black paint; others with creosote. Those coated with creosote are objectionable to the trade because they cause stains and the stain from each tie may ruin many yards of fabric.

Bale coverings may be of jute weighing 12 pounds per pattern, of sugar bag cloth weighing 10½ pounds per pattern, of cotton weighing 4.5 pounds per pattern, or of other material. As the bales progress through compression establishments, the number of ties and strength of buckles used are increased.

Gin Buildings and Press Types.

The arrangement of ginning machinery depends upon the type of building in which it is housed. Existing gin buildings in the United States are about equally divided between single-story structures, 1-1/2-story structures having elevated press decks, and 2-story structures. Single-story gins have their machinery on the ground floor and employ special types of single-story presses of recent types, or resort to older forms of construction with the lower half of the press submerged in a pit below floor level. New presses in single-story gins may be either down- or up-packing, and are usually of all-steel construction. Gins of the 1-1/2-story type place their machinery on the ground floor with exception of the press which is elevated above the floor level and operated from a cotton deck about 5 to 8 feet above the ginning floor. The presses may be of essentially all-wood, part-wood, or all-steel construction. Even in wooden presses, columns are used to unite the bottom sills and top platens. Modernization of wooden presses has led to improved locks on the doors, metal bindings on the wooden boxes, and better rams. Two-story gins employ the same kinds of up-packing presses found in 1½-story gins.

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[1] Wright, John W., and Bennett, Chas. A. The Compression of Cotton and Related Problems. USDA, Nov. 1940. (Unnumbered mimeographed circular.)

Engineering Features and Performance of Gin Presses.

From an engineering viewpoint, the important elements of a cotton press are: (1) The condenser and packing equipment; (2) the press frame with boxes, turntable and other incidental items; and (3) the pressing mechanism proper, which may comprise the screw and its drives or the hydraulic ram with pump, piping and controls.

The condenser of a cotton-gin press delivers a bat of cotton to the lint slide from which it is "kicked" into the receiving cotton box periodically between the tramper strokes which push the fiber downward past retaining "dogs" which protrude into the press boxes. Trampers make about five strokes per minute while the cotton box is being filled, and are shut off at high position when turning the box to pressing position.

Frames of cotton-gin presses may be of wood, metal or both. The center columns are universally of metal, having square or round circular cross-section, and the "sway or brace rods" on the outboard ends of the sills and platens (upper beams) are made of steel. The latest form of cotton press has a structural-steel frame throughout, with a cylindrical center column upon which the double box is pivoted with a tubular sleeve and suitable ball-bearing turntable.

The depth of cotton press boxes is about ten feet, and the usual horizontal cross section is 2 feet, 3 inches, by 4 feet, 6 inches, or 10.125 square feet.

The actual pressing with hydraulic rams of the predominant type is accomplished with ram strokes of seven feet or more for the conventional 1-1/2 and 2-story up-packing presses. The plungers are of various sizes, but new press rams are standardized at 8-3/8 inches or 9-1/2 inches diameter. They are usually of cast iron, machined sufficiently to eventually become polished in operation. Casings for the plungers have been of cast iron or cast steel, but are now made of ten-inch, extra-heavy steel pipe, plugged at one end and capped with gland and stuffing box for the ram at the other end.

Single- and double-packing glands are in use on cotton gin rams, and the new presses are equipped with overflow connections through which fluid from safety slots at the base of the ram may discharge when the pressure has reached the safety limit.

Considering normal pressing loads requiring about 1,200 pounds hydraulic pressure p.s.i. on dry cotton, the conventional 8-3/8-inch ram develops a thrust of 33 tons as compared to 42-1/2 tons with a 9-1/2 inch ram. The large rams are growing in favor because of their greater thrust and also because they are adaptable to the 10-inch pipe casing. The follow-block, which rides upon the ram, applies pressures against the cotton of approximately 3-1/2 to 4-1/2 tons per square foot in the usual press box having a cross-sectional area of 10-1/8 square feet.

It may be of engineering interest to note that the major elements of this all-steel construction comprise hot-rolled steel slab sills and platens united between one 6" center column and two outboard 4½" strain rods. The sills and platens were each made up of four slabs, the two outside units being 2" by 20" in cross-section and the two inside being 3" by 18" in cross-section. Center column and strain rods were held in position with standard nuts on slab steel saddles which span the sill members. A maximum load of 500 tons is contemplated for the three rams whose travel is slightly more than 8 feet.

One side of the press is fitted with a box 20 inches wide by 54 inches long by 111-1/2 inches deep; the other side is the conventional 27-inches by 54 inches by 111-1/2 inches in size. Bales of equal density pressed in the two boxes require different hydraulic pressures, that from the narrow box requiring about half as much as that from the wide one. Thus a reduction of 25 percent in width has produced a reduction of 50 percent in the required hydraulic pressure on the rams. The optimum dimensions of a cotton-press box are still unknown.

Pumping and Piping Arrangements

Present-day gin press mechanical pumps operate at speeds ranging from 150 to 250 strokes per minute. The various types in use represent vertical triplex, horizontal triplex, quadruple, and sextuple designs. The bores of the brands of pumps now extensively used vary from 1-3/8 to 1-3/4 inches; the strokes vary from 3-1/2 to 4 inches in length.

Steam pumps, found in a number of gins, have various bores and strokes. A typical steam pump has an 8-1/2-inch steam cylinder, a 1-1/2 inch water plunger, and a 10-inch stroke at 150 strokes per minute with 75 pounds steam working pressure. Both this pump and the hydraulic pumps previously mentioned are suitable for ram pressures up to 2,000 pounds p.s.i.

For the experimental standard-density press, various piping systems have been devised.

Pressing fluids may be either water or oils; the latter are preferred if they are petroleum oils of a type that does not tend to explode under high pressures. Water, because of its economy, is used by most cotton gins, but oil preserves the ram polish and assists lubrication through the packing rings.

Since rates of pumping should approach 16 gallons or more per minute for the larger cotton gins, double extra-heavy 1-1/4 inch pipe, with forged steel valves and fittings, is frequently used. The valves are usually manually operated, and the pumps are run continually on by-pass, no-load circuits when not pressing.

Special "knock-outs" have been invented at the Cotton Ginning Laboratory to retain low-power requirements as pressures rise, by simply cutting pump cylinders out of load service on proportionate steps of pressure.

Conclusion

The engineers, economists, and technologists of the United States Department of Agriculture are searching for the facts which bear upon the engineering and mechanical feasibility of packaging cotton in higher-density 500-pound bales at the gins, and are studying the comparative costs and advantages of much higher-density gin pressing, as compared to customary procedures. They also seek to determine the effect of higher densities on the spinning value of cotton; to work out the requirements for a higher-density gin bale package which will best serve all needs; and to ascertain the mechanical and economic feasibility of devising cotton-gin equipment and operating methods which will insure that all the cotton in a bale is of uniform quality.